Arrowhead Silica

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Report

on

KYANITE, MUSCOVITE, GARNET, BIOTITE DEPOSIT

Butler and Antoine Townships

District of Nipissing

Ontario

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Location and Access:

The property of the Kyanite Corporation of Canada, Limited, consists of a group of 31 claims in the north-east corner and the north-west corner of Butler and Antoine Townships in the District of Nipissing in the Province of Ontario. The main deposit lies to the north-east of Crocan Lake and is easily accessible by road from Mattawa, 23 miles to the south-east. It is also 2 miles west of the Ottawa River and about 6 miles east of the paved highway between North Bay and Temiskaming. A hydro plant is located on the Ottawa River about 16 miles to the south-east.

History and Development:

The extensive deposits of kyanite-muscovite-garnet- biotite gneiss, were discovered in 1951. Preliminary investigation indicated that the grade and uniformity of the deposits warranted detailed investigation and as a result 2500 feet of diamond drilling was completed and a considerable amount of samples were shipped out for separation tests.

Detailed mapping and prospecting has shown that the broad area of kyanite-muscovite-garnet-gneiss extends over an area approx. 1800' wide and 11,000 feet long. The general strike is in a north-easterly direction with the beds dipping from 35° to 40° to the north-west. A tonnage of at least 50,000,000 tons has been estimated.

Geology of the Occurrence:

Geologically, the deposit lies in an area of the Grenville sub-province of the Precambrian Sheild. In general, the geology consists of highly folded meta-sediments of the Grenville type in which the rock types remain remarkably conformable.

The deposit consists of a wide band of kyanite-muscovite-

garnet-biotite-quartz-feldspar gneiss striking in a north-easterly direction and dipping about 35° to 40° to the north-west. The hanging wall gneisses to the north-west are biotite amphibolite, the footwall gneisses to the south-east strongly foliated biotite amphibolites. The country rock is a pink granite gneiss.

The deposit consists of two types, namely disseminated and massive. The disseminated type of which the greater part of the deposit is formed, is fairly uniform and consists of coarse-grained, flat-bladed gray to blue kyanite crystals 1/2 to 3 inches long and 1/8 to 3/8 inches wide with pinkish-mauve garnet crystals up to ½ inch in diameter, muscovite and biotite mica. The kyanite forms up to 25% of the rock, but probably averages in the order of 15 to 20%.

The massive type or variety occurs in the form of lenses or pod-like masses and stringers particularly along the contact of the kyanite gneiss, quartzite and dark gneisses of the hanging and footwall. In some of these massive lenses the kyanite forms up to 90% of the rock. These are limited in size, but one deposit at the south end of Crocan Lake showed a flat lying lense about 10 feet thick and upwards of 150 feet in length and which has not been delimited as to length.

There is another massive kyanite deposit (60%) known locally as 'B' zone where on the hanging wall contact with pyritized quartzite there exists a width of approximately 50 feet in low ground and traced for 100 feet in length. This has been trenched but has never been tested by drilling. It is apparent that there may be many other massive (60% to 90%) kyanite zones or lenses along the two miles of favourable contacts. However, at present the merits of the property are not based on these high grade lenses but on the unlimited tonnages of disseminated kyanite gneiss averaging in the order of 15 to 20%

kyanite and the accompanying commercial by-products such as muscovite and garnet.

The economics of kyanite and the other associated minerals are treated separately in this report.

These two types of kyanite-rich occurrences along with the associated muscovite, garnet and biotite clearly indicated that the deposit warranted detailed milling tests for the efficient recovery of these economic minerals, which tests were subsequently carried out by the Mines Branch at Ottawa, American Cyanamid and others. Details of separation tests are treated separately in this report.

Constituents:

The kyanite - muscovite - garnet - biotite gneiss could be more particularly described as follows:

Kyanite----------15 to 20%

Muscovite----------20 to 40%

Garnet----------10 to 20%

Biotite----------15 to 25%

These minerals occur in variable amounts throughout the whole deposit.

Milling:

(1) Milling investigations have been concentrated chiefly on the disseminated variety of kyanite. With the increasing importance of muscovite and garnet the tests were carried out with the idea in mind of extracting all three products and possibly the black biotite mica.

Crushing & Grinding:

Initial investigation into methods of concentration has indicated two stages of grinding. First, a dry grind through 20 mesh when magnetic separation could recover the biotite and garnet. The second, prior to flotation when the feed could be wet ground through 48 mesh.

Three desirable features in the primary grind were found to be: (1) Release of the minerals at their natural grain size, (2) delamination of the micas to help subsequent concentration and (3) minimum production of fines.

Initial crushing in jaw and roll crushers to about ¾ - inch. An impact mill similar in action to a hammer mill but owing to the absence of grates there is less excess abrasive wear. The operation and product of this type of mill proved most satisfactory. Closed circuite screening at 14 - mesh was very efficient.

Wet grinding has proven successful in both rod and ball mills in closed circuite with a Hummer screen.

Concentration:

Early investigations results in three suitable stages of concentration:

(1) High intensity magnetic separation to remove effectively all the garnet and biotite.

(2) Use of air tables to remove the muscovite and leaving a kyanite concentrate along with quartz and minor mica.

(3) The air-table concentrate was ground to 48 - mesh and a kyanite concentrate of commercial grade obtained by flotation.

To summarize the results of the concentration, the overall recovery of kyanite in both dry and flotation stages of concentration, utilizing the air-table is about 72% with the production of a 90% kyanite concentrate. By eliminating the air-table and floating the magnetic tailing directly the recovery is increased to 80%.

Chemical analysis of a flotation concentrate and of a cleaned sample of kyanite from the concentrate are given below.

	Concentrate	Kyanite
Al_2O_3	59.09	62.22
$Si\ O_2$	39.24	36.40
Fe_2O_3	0.87	0.74

Economics:

The deposit of kyanite-muscovite-garnet-biotite gneiss as described above, and the tremendous tonnage involved would certainly appear to be of great economic importance to the industrial growth which has been evident in Canada for the past ten years and which appears to be even greater as time goes on. The occurrence of the industrial minerals described herein most certainly warrants considerable development and early production. A more careful and detailed study of market conditions for these minerals must be carried out in Canada, the United States and abroad. The Canadian production of these minerals is indeed very limited. A study made on them over the past few months would definitely indicate that a great potential market is available and awaits only an intensive and progressive attempt to make the products available to Canadian industry. This can be done economidally when one figures the import data and the current prices which various companies have to pay for the same raw materials as used in the numerous industries in Canada and the U. S..

A brief discussion on each of the minerals follows and is by no means a detailed and final summary of their economical importance.

Kyanite:

Kyanite is commercially valuable because of its property of converting to mullite and a little free silica when heated to a temperature of 1300° to 1600° C. Mullite is used in the manufacture of refractory materials to withstand high temperatures, resistance to thermal shock and corrosive actior of some highly reactive slags. It must also have a low co-efficient of expansion. These features are all important in production of bricks and shapes for lining metallurgical furnaces for melting brasses, bronzes and other alloys as well as in the glass industry where mullite refractories are employed in glass-

melting tanks and furnaces.

Owing to the dependence of the United States on kyanite from India and British East Africa (Kenya) this mineral can be considered to be strategic now and in the immediate future should a state of national emergency develop. The African supply is not too reliable at the present time due to depletion of high grade reserves and for some time the Indian kyanite has all but dried up due principally to higher labour costs, deteriorating quality and a higher asking price.

The kyanite produced from test runs on the Mattawa ore at Ottawa has indicated that it is by far the best they have worked on to date.

An analysis of a flotation concentrate on cleaned kyanite from the Mattawa deposits is as follows:

	Concentrate %	Kyanite %
Al_2O_3 ----------	50.09	62.22
SiO_2 ----------	39.24	36.40
Fe_2O_3 ----------	0.87	0.74
MgO ----------		0.19
L.O.I ----------		0.30

A continued demand for high-temperature refractories together with further research into new uses for this kyanite should lead towards establishing a sound kyanite industry in Canada.

Interesting possibilities are also evident from exploration and milling investigations on the Mattawa kyanite, from which important co-products have been produced such as muscovite and biotite mica and garnet. The success of the kyanite market is further enhanced by the new and varied uses for ground muscovite mica such as in the protective paint industry and for insulation purposes and on the expanding uses of garnet in large tonnages in the sand-blasting and glass polishing industries.

It is generally known that if there was more kyanite that

greater uses for it could be found.

The market price for U. S. kyanite is about $50.00 per ton f.o.b. shipping point. The India Kyanite ranges from $60.00 to $150.00 per ton f.o.b. Atlantic seaboard.

Muscovite Mica:

Muscovite mica may be considered to be one of the most important products from the deposit. The average content in the deposit is about 27% as derived from a large bulk sample taken for extensive test purposes by the Mines Branch at Ottawa. The mica as produced will range in size between 14 and 100 mesh and will be suitable for the ground mica trade. In recent years new markets have developed for ground mica in such products as special types of paints; its flake-like characteristics give greater coverage, make them more flexible and so on. Bitumastic products such as pipe line enamels, tank and structural coatings, roof coatings have shown greater life and flexibility with mica. Other common uses for mica are in cement p for prous surfaces, fire-retardant paints, wallboard and wallpaper coatings and in the rubber industry. A new product developed by General Electric called Mica Mat utilizes finely ground mica.

In recent years the supply of ground mica has been very poor and the demand high, especially for the wet-ground mica. The Mattawa kyanite would be essentially a dry ground mica which would sell for around $50.00 per ton, but with a well planned milling plant the wet ground mica at about minus 200 mesh could be produced which would bring a considerably higher price, in the range of $80.00 to $200.00 per ton. At the present time there is no wet-ground mica produced in Canada.

A careful study of the ground mica market might prove to be the most significant feature in production of the industrial

minerals from the Mattawa deposit and thereby defray the cost of production of high grade kyanite.

Garnet:

There has been no domestic production of garnet for the past few years, but here again the market should develop with anticipated production. The average garnet content from a composite sample was 14% and milling tests have indicated that a good clean garnet concentrate cam be produced below 20-mesh from the Mattawa deposit.

The consumption of garnet in the U. S. and Canada combined is about 12,000 tons per year but market research indicates that this figure could be substantially increased with increased production. At the present time the only production of garnet of any importance comes from the Barton Mines Corporation near North Creek, N. Y. The deposit averages 8 to 10% and the intimate association of hornblende with the garnet makes it difficult to make a clean concentrate.

Producers of garnet abrasive ship their garnet as a concentrate rather than as finished grain size ready for use, since the various manufacturers of garnet paper and cloth have their own individual specifications as to grain size. Crude garnet concentrate sells for about $100.00 per ton. Again, adequate milling equipment to produce the so-called flour-garnet for the glass polishing and optical trades will prove to be a profitable venture since prices for this type of finely pulverized garnet are quoted as high as $800.00 per ton.

Since there is a short supply of garnet for sand blasting, abrasive cloths, etc., industry has been forced to use fused alumina which is very expensive, costing about 10¢ per pound or $200.00 per ton. At the present time there is no production of garnet in Canada.

The sand-blasting trade is using larger tonnages yearly and a substution of garnet for silica sand makes for a more efficient and

effective job especially since the garnet can be recovered for further use by electro-static methods. Steel foundries and aircraft casting manufacturers are employing sand-blasting techniques on a vastly greater scale each year and could use considerable quantities of garnet if it was available.

BIOTITE:

The biotite (dark) mica forms about 18% of the Mattawa ore and has been successfully separated by magnetic means the same as the garnet with a recovery of 80%. The Blackburn Bros. of Ottawa grind biotite-mica and are constantly searching for raw material and are paying upwards of $25.00 per ton for such material. The ground micas go to the roofing manufacturers for backing asphalt shingles and mineral surfaced rolled roofings. The rubber manufacturers use the ground dark micas for dusting on car tubes etc. and the price for this product, ready for use, is approximately $42.00 per ton in bags. Biotite, like muscovite, is ideal for corrosion-resisting pipe line coating for below-ground installations.

CONCLUSION:

The Mattawa deposit of kyanite, muscovite, garnet and biotite which contains upwards of 50,000,000 tons of ore to a depth for efficient open pit operation could prove to be of inestimable importance to Canada's industrial growth now and over the next twenty years. It is hardly necessary to stress the importance of such a storehouse of important strategic materials as the kyanite and the muscovite in the event of a national emergency, when present sources of these minerals which are outside of North American continent may be suddenly discontinued.

The deposit lends itself favourably to an open-pit operation for several years before it would be necessary to go to underground

methods of mining. Production could be started almost immediately.

Considerable research has already been done on the ore by the Mines Branch at Ottawa with favourable results. An official of the Mines Branch has stated that the Mattawa kyanite is of exceptionally good grade and is the best to date they have encountered in their investigations and it is planned that in the near future considerable research work is to be done especially on the flotation of the kyanite.

It must be kept foremost in mind that the marketing of the economic minerals from this deposit is of greatest importance and that considerable detailed research will be required to make any operation successful. A large and aggressive sales organization under experienced guidance will of necessity be required.

Very limited research into existing markets and prices has indicated there is an excellent opportunity to develop a profitable industry around the Mattawa deposit. Personal discussions with persons familiar with the Industrial Mineral situation has indicated there is a good opportunity of expanding existing markets with the start of production.

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